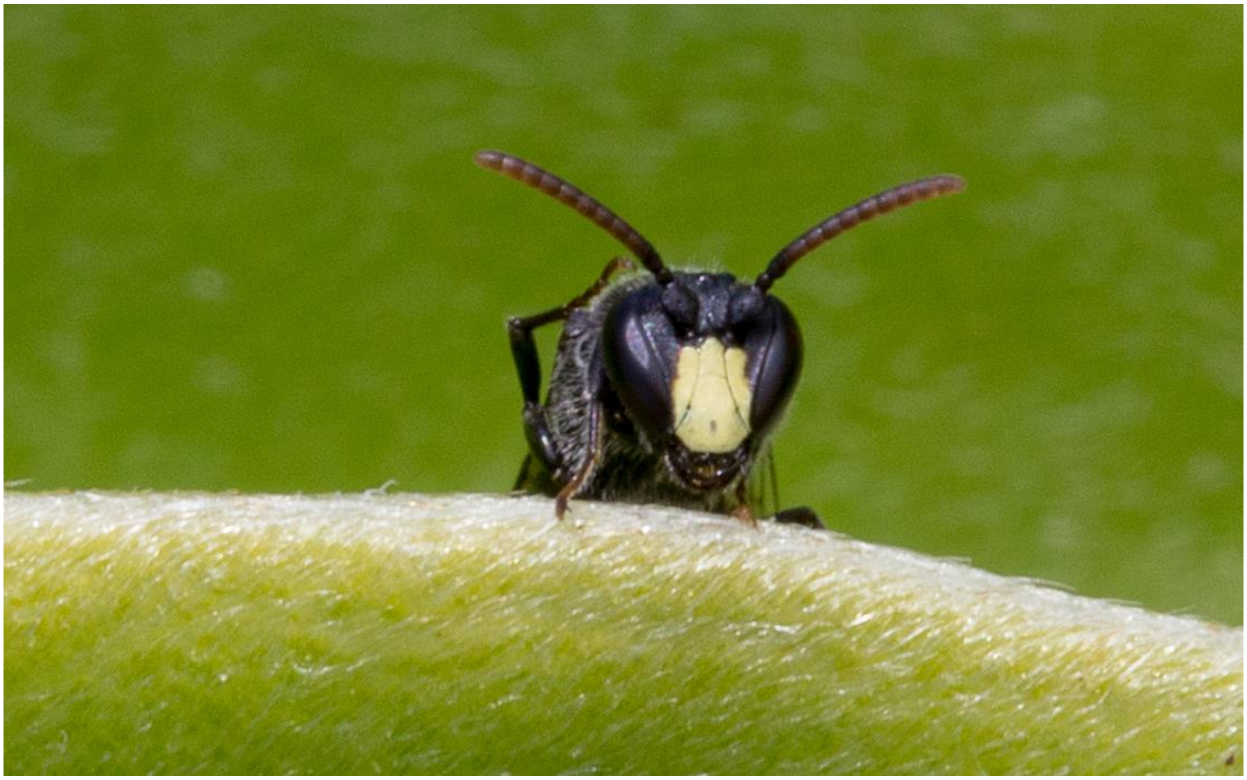
Species Report for the Anthracinan yellow-faced bee (*Hylaeus anthracinus*)
Version 1.0



Cover. The anthracinan yellow-faced bee (*Hylaeus anthracinus*) (male). Photo provided by Dr. Karl Magnacca.

June 2021
Pacific Island Fish and Wildlife Office
U.S. Fish and Wildlife Service
Honolulu, HI

This document was prepared by the staff at the Pacific Islands Fish and Wildlife Office, Honolulu Hawaiʻi. We received valuable input and assistance from the following experts: Dr. Karl Magnacca, Oahu Army Natural Resources Program; Dr. Paul Krushelnycky and Dr. Kenneth Kaneshiro, University of Hawaiʻi at Mānoa; and Cynthia King, Dr. Will Haines, and Mr. Keahi Bustamente, State of Hawaiʻi, Department of Land and Natural Resources, Division of Forestry and Wildlife. We greatly appreciate their guidance and support, which resulted in a more robust report.

Suggested reference:
U.S. Fish and Wildlife Service. 2021. Species report for the anthracinan yellow-faced bee (*Hylaeus anthracinus*). Pacific Islands Fish and Wildlife Office, Pacific Islands Interior Region 12, Portland OR. 42 pp.

EXECUTIVE SUMMARY

This Species Report for the anthricinan yellow-faced bee (*Hylaeus anthracinus*), was completed to assess the species' biology, threats, conservation actions, and current status. The U.S. Fish and Wildlife Service identified the species' ecological requirements for survival and reproduction at the individual, population, and species levels, and identified the factors influencing the species current condition. We used the conservation biology principles of resiliency, redundancy, and representation to assess the overall viability for the anthracinan yellow-faced bee.

The anthricinan yellow-faced bee is a member of the family Colletidae and the subgenus Nesoprosopis. Endemic to the Hawaiian archipelago, the anthracinan yellow-faced bee is known from the coastal strand and lowland dry forest habitats up to 2,000 feet (610 meters) in elevation. Historically known from Oʻahu, Molokaʻi, Lānaʻi, Maui, and the island of Hawaiʻi, its current range also includes Kahoʻolawe, but it is considered extirpated from Lānaʻi. This medium-sized bee is a solitary bee that nests in natural cavities in coral, rocks, stems, twigs, existing burrows made by other invertebrates, or manmade artificial burrows.

The diet of yellow-faced bees is almost exclusively pollen and nectar from native plants though anthracinan yellow-faced bee has been observed visiting nonnative *Heliotropium foetherianum* (tree heliotrope). Once widely distributed and abundant, this bee species has declined precipitously with the loss of coastal habitat. Primary threats to the anthracinan yellow-faced bee are: (1) degradation and loss of its native habitat foraging resources; (2) predation by nonnative ants on the defenseless egg, larvae, and pupal stages; and (3) lack of food and nesting resources. The principal means of conserving the species is through protecting and restoring the bee's habitat. Such habitat must provide nesting and diverse native pollen and nectar resources that are simultaneously available.

For the purpose of this Species Report, viability is the ability of the anthracinan yellow-faced bee to persist over time and avoid extirpation. A species is considered viable when there are a sufficient number of self-sustaining populations (resiliency) distributed across the full range of the species (redundancy) and occupying its breadth of habitats to maintain environmental and genetic diversity (representation) so as to allow the species to adapt and persist indefinitely when faced with annual environmental stochasticity and infrequent catastrophic events. The anthracinan yellow-faced bee is currently known to occur on five islands in the coastal strand and dry lowland forest habitats: four coastal locations on Oʻahu, one coastal and one dry forest location on Maui, three coastal locations on Molokaʻi, a coastal location on Kahoʻolawe, and five coastal and possibly one montane dry forest population on the island of Hawaiʻi. In general, the populations are small and patchily dispersed. The species was not observed in many areas that contained suitable pollen and nectar sources, suggesting the availability of nesting substrates and presence of threats constrain the location of the populations.

Resiliency of the anthracinan yellow-faced bee populations is low to moderate because of small population size and disjunct populations. The species has low to moderate redundancy because the species is extirpated from Lānaʻi and greatly reduced across its historic range on the five islands where it is extant. Species representation is moderate because populations are isolated, but genetic diversity is present. Therefore, the current viability of the anthracinan yellow-faced bee is low to moderate.

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SPECIES REPORT OVERVIEW

Introduction

The anthracinan yellow-faced bee (*Hylaeus anthracinus*) is a member of the family Colletidae. This medium-sized yellow-faced bee nests opportunistically in existing burrows, natural crevices in coral or rocks, dead stems or twigs, or manmade artificial nests. The anthracinan yellow-faced bee is historically known from the coastal strand and lowland dry forest habitats up to 2,000 feet (ft) (610 meters [m]) on Oʻahu, Molokaʻi, Lānaʻi, Maui, and the island of Hawaiʻi. Recently, the species was found on Kahoʻolawe, though it is now considered extirpated from Lānaʻi. The species, once common and widely distributed has declined precipitously over the last 100 years and is currently known from only 15 populations on 5 islands. Habitat degradation and loss, predation by ants and wasps, competition for food resources, and loss of native pollen and nectar resources threaten the existence of this once widely distributed bee.

This Species Report, prepared by the Pacific Islands Fish and Wildlife Office, summarizes the biology and current status of the anthracinan yellow-faced bee. The Species Report provides an in-depth review of the species' biology, threats, and conservation actions that influence viability, followed by an evaluation of current species status and viability.

The intention of the Species Report is for it to be easily updatable and to support the functions of the Service's Endangered Species Program. The Species Report is a living document upon which other documents, such as recovery plans and 5-year reviews, will be based.

Regulatory History

The anthracinan yellow-faced bee was listed as endangered on September 30, 2016 (USFWS 2016a, entire). On June 11, 2019, the Service published a notice of the initiation of the 5-year status review of the anthracinan yellow-faced bee and information solicitation (USFWS 2019, entire). The Recovery Outline for Multi-Island Species includes the anthracinan yellow-faced bee and is under review (USFWS 2020, entire).

No critical habitat has been designated for the species.

Methodology

We used the best scientific and commercial data available to us, including peer-reviewed literature, grey literature (government, academic, business, and industry reports), and expert elicitation.

This Species Report assesses the ability of the anthracinan yellow-faced bee to maintain viability over time. Viability is the ability or likelihood of the species to maintain populations over time (i.e., likelihood of avoiding extinction). To assess the viability of the anthracinan yellow-faced bee, we used the three conservation biology principles of resiliency, redundancy, and representation, or the "3Rs" (Figure 1; USFWS 2016b, entire). We will evaluate the viability of this species by describing what the species' requires to be resilient, redundant, and represented, and comparing that to the status of the species in its current condition based on the most recent information available.

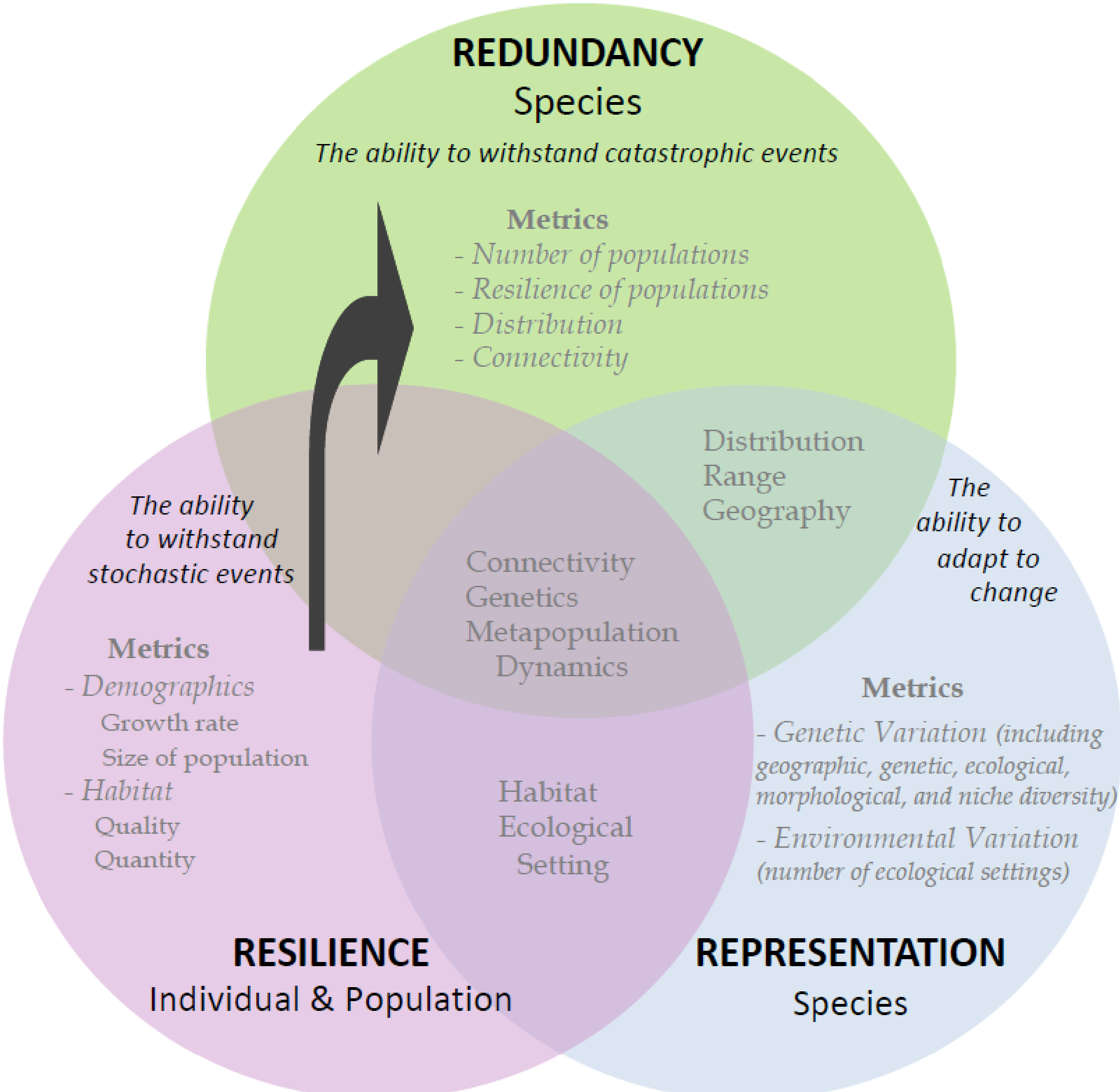

Figure 1. The three conservation biology principles of resiliency, redundancy, and representation (3Rs) used to assess species viability.

Definitions
Resiliency

Resiliency is the capacity of a population or a species to withstand the extreme limits of normal year-to-year variation in environmental conditions such as temperature and rainfall extremes, and unpredictable but seasonally frequent perturbations such as fire, flooding, and storms (i.e., environmental stochasticity). Quantitative information on the resiliency of a population or species is often unavailable. However, a population or species found within a known area over an extended period of time (e.g., seasons or years) is likely to be resilient to current environmental stochasticity. If quantitative information is available, a resilient population or species will show enough reproduction and recruitment to maintain or increase the numbers of individuals in the population or species, and possibly expand the range of occupancy. Thus, resiliency is positively related to population size and growth rate, and may be influenced by the connectivity among populations.

Redundancy

Redundancy is having more than one resilient population distributed across the landscape, thereby minimizing the risk of extinction of the species. To be effective at achieving redundancy, the distribution of redundant populations across the geographic range should exceed the area of impact of a catastrophic event that would otherwise overwhelm the resilient capacity of the populations of a species. In the report, catastrophic events are distinguished from environmental stochasticity in that they are relatively unpredictable and infrequent events that exceed the more extreme limits of normal year-to-year variation in environmental conditions (i.e., environmental stochasticity), and thus expose populations or species to an elevated extinction risk within the area of impact of the catastrophic event. Species redundancy is conferred when the geographic range of the species exceeds the impact area of a catastrophic event. In general, a wider range of habitat types, a greater geographic distribution, and connectivity across the geographic range will increase the redundancy of a species and its ability to survive a catastrophic event.

Representation

Representation is having more than one population of a species occupying the full range of habitat types used by the species. Alternatively, representation can be maintaining the breadth of genetic diversity within and among populations, in order to allow the species to adapt to changing environmental conditions over time. The diversity of habitat types, or the breadth of the genetic diversity of a species, is strongly influenced by the current and historic biogeographical range of the species. Conserving this range should take into account historic latitudinal and longitudinal ranges, elevation gradients, climatic gradients, soil types, habitat types, seasonal condition, etc. Connectivity among populations and habitats is also an important consideration in evaluating representation.

Species Viability

Species viability is derived from the combined effects of the 3Rs. A species is considered viable when there are a sufficient number of self-sustaining populations (resiliency) distributed over a large enough area across the range of the species (redundancy) and occupying a range of habitats to maintain environmental and genetic diversity (representation) to allow the species to persist indefinitely when faced with annual environmental stochasticity and infrequent catastrophic events. The 3Rs share ecological factors such as connectivity among habitats across the range of the species. Connectivity sustains dispersal of individuals, which in turn greatly affects genetic diversity within and among populations. Connectivity also provides access to the full range of habitats normally used by the species and is essential for re-establishing occupancy of habitats following severe environmental stochasticity or catastrophic events (see Figure 1 for more examples of overlap among the 3Rs). Another way the three principles are inter-related is through the foundation of population resiliency. Resiliency is assessed at the individual and population level; redundancy and representation are assessed at the species level. Resilient populations are the necessary foundation needed to attain sustained or increasing Representation and redundancy within the species. For example, a species cannot have high redundancy if the populations have low resiliency. The assessment of viability is not binary, in which a species is either viable or not, but rather on a continual scale of degrees of viability, from low to high. The health, number, and distribution of populations were analyzed to determine the 3Rs and viability. In broad terms, the more resilient, represented, and redundant a species is, the more viable the species is. The current understanding of factors, including threats and conservation actions, will influence how the 3Rs and viability are interpreted for the anthracinan yellow-faced bee.

SPECIES ECOLOGY

Species Description

The genus *Hylaeus*, in the family Colletidae and subfamily Hylaeinae, is widespread and very diverse in the Hawaiian Islands, with at least 60 native species, including 38 that are considered endemic to a single island (Michener 2000 entire; Magnacca and Danforth 2006, entire; Magnacca 2007, entire). The geographic origin and characteristics of the initial *Hylaeus* colonists in Hawaiʻi are unknown, but the nearest relatives of the native Hawaiian species are the *Hylaeus* (formerly *Nesoprosopis*) species in Japan (Daly and Magnacca 2003, pp. 7–8; Magnacca 2007, pp. 173–174). The native *Hylaeus* spp. of Hawaiʻi are believed to have evolved from a single lineage of the genus *Hylaeus* (Daly and Magnacca 2003, p. 3). The anthracinan yellow-faced bee was described as *Prosopis anthracina* by F. Smith (1873) and transferred to the genus *Nesoprosopis* by Perkins in 1899. The *Nesoprosopis* genus was eventually reduced to a subgenus of *Hylaeus* (Meade-Waldo 1923, entire) and the species renamed *Hylaeus anthracinus*. Daly and Magnacca (2003) is the most recent taxonomic treatment for this species.

There is weak genomic evidence that the anthracinan yellow-faced bee may be a species complex, though biological evidence for this division is not available (Magnacca and Brown 2010, pp. 7–9). Mitochondrial deoxynucleic acid sequencing loosely placed Oʻahu and Molokaʻi individuals within a group and individuals from Maui, Kahoʻolawe, and the island of Hawaiʻi in another group (Magnacca and Brown 2010, p. 7). Divergence between genetic sequences increases from intraisland to interisland, but sequence similarities overlap among populations (Magnacca and Brown 2010, pp. 4, 9), which provides evidence of genetic exchange.

In general, *Hylaeus* spp. are small to medium sized bees with forewing lengths of about 0.12 to 0.31 inches (in) (3 to 8 millimeters [mm]), slender bodies that are usually black, short-bilobed tongues, and two submarginal cells (the row of cells behind the cells along the front edge of the forewing) in the forewing (Daly and Magnacca 2003, p. 12). Males of most of the *Hylaeus* spp. and females of several *Hylaeus* spp. have yellow marks on their face, hence the common name "yellow-faced bees" (Cover). *Hylaeus* spp., in general, lack the elongated hairs on the hind legs that other bee genera use to carry pollen externally. The lack of these hairs gives them a wasp-like appearance. But, yellow-faced bees can be distinguished from wasps by the presence of branched hairs on the body that are longest on the sides of the thorax (Michener 2000, entire).

The anthracinan yellow-faced bee is a medium sized, black bee in the family Colletidae and subfamily Hylaeinae. The species has clear to smoky colored wings and black legs. The male has an oval yellow mark on its face that covers the entire clypeus (lower face region), and a narrow yellow strip below the antennal sockets that runs alongside the clypeus (Cover). The female is entirely black (Figure 2). The anthracinan yellow-faced bee commonly occurs with *Hylaeus longiceps* and *Hylaeus flavipes*. The anthracinan yellow-faced bee female can be distinguished from them by the black hairs on the end of the abdomen and the unusual mandible with three teeth, which is a character only shared with its sister species on Kauaʻi, the very yellow-faced bee (*Hylaeus flavifrons*) (Daly and Magnacca 2003, p. 53). A more detailed description of the species can be found in Daly and Magnacca (2003, pp. 81–83).

The anthracinan yellow-faced bee, like most *Hylaeus* spp., have abundant curved hairs on the foreleg that function in gathering pollen for nest provisioning. A female grooms the pollen off her head and the curved hairs on her forelegs and transfers the pollen to her internal crop for transport to her nest. The rest of the pollen is discarded (Michner 2000, p. 84). Transport of the pollen in the internal crop, rather than on external, abundant elongated hairs on the hindleg, is unique to bees in the subfamily Hylaeinae (Michner 2000, p. 15). The bees concentrate nectar by holding a drop between their mandibles to evaporate the water. Because *Hylaeus* spp. carry pollen internally in the crop instead of on body hairs, the nectar is often cloudy with pollen grains (Figure 2).

Figure 2. Female anthracinan yellow-faced bee with nectar drop visiting *Sida fallax* (ʻilima) plant at Puʻuhonua o Hōnaunau National Historic Park on the island of Hawaiʻi. Photo provided by Dr. Karl Magnacca.

Habitat

Hawaiian *Hylaeus* spp. group within two categories: ground-nesting species that require relatively dry conditions and stem-nesting species found within wetter areas (Daly and Magnacca 2003, p. 11). Nests of the anthracinan yellow-faced bee are usually constructed opportunistically within coral rubble or rocky substrates, or in stems of coastal shrub species, where they seek out existing cavities that they suit to their own needs (Magnacca and King 2013, pp. 13–14). This is unlike the nest construction of many other bee species, which are purposefully excavated or constructed underground.

The anthracinan yellow-faced bee was historically known from numerous coastal and lowland dry forest habitats up to 2,000 ft (610 m) in elevation on the islands of Oʻahu, Molokaʻi, Lānaʻi, Maui, and the island of Hawaiʻi, and more recently, Kahoʻolawe (Daly and Magnacca 2003, pp. 55, 217). Anthracinan yellow-faced bees commonly occur with other *Hylaeus* species. Its coastal habitat occurs in a relatively narrow belt around each island from sea level to 980 ft (300 m) in elevation. Composition of this habitat is strongly influenced by the ocean, salinity in the root zone, salt spray, and geologic shoreline processes (Cuddihy and Stone 1990, entire; Kim et al. 2020, entire). The coastal substrate consists of well-drained talus (the pile of rocks that accumulate at the base of a cliff, chute, or slopes), calcareous (limestone) slopes, dunes, and coral ruble. This system can be dry, with annual rainfall less than 50 in (120 centimeters [cm]), mesic (50 to 100 in [120 to 250 cm]), or wet (more than 100 in [250 cm]) (Kim et al. 2020, entire).

Native coastal strand habitats are dominated by *Achyranthes splendens* var. *rotundata* (ʻewa hinahina), *Euphorbia* spp. (pōpolo, ʻakoko), *Gossypium tomentosum* (maʻo, Hawaiian cotton), *Hibiscus* spp. (hibiscus), *Jacquemontia ovalifolia* subsp. *sandwicensis* (pāʻū o Hiʻiaka), *Myoporum sandwicense* (naio), *Nama sandwicensis* (nama), *Santalum ellipticum* (ʻiliahi, sandalwood), *Scaevola* spp. (naupaka kahakai), *Sesbania tomentosa* (ʻōhai), *Sesuvium portulacastrum* (ʻākulikuli), *Sida fallax* (ʻilima), *Sophora chrysophylla* (māmane), *Vigna* spp., *Vitex rotundifolia*, and *Wikstroemia uva-ursi* (ʻakiʻa) (Kim et al. 2020, entire), some of which are known food resources for the anthracinan yellow-faced bee (Daly and Magnacca 2003, p. 217; Magnacca 2007, p. 186). Coastal habitats are highly valued for development, popular for recreation, typically dry and therefore vulnerable to fire, susceptible to invasion by exotic plants, and cover a small area of each island (Magnacca 2007, entire). As a result, intact coastal habitats have become extremely limited in Hawaiʻi; most islands have few, if any, coastal sites with diverse native vegetation that are protected (Figures 3, 4, and 5).

Dry forests have relatively low annual rainfall between 12 and 79 in (30 and 200 cm) and are found on the leeward sides of the islands in lowland or in montane-subalpine zones. Ranging in elevation from 1,000 to 2,900 ft (305 to 884 m), dry forests are located on all of the main Hawaiian Islands (Gagne and Cuddihy, 1999, entire; Javar-Salas et al. 2019, entire). Characteristic plants in the dry forest include *Acacia koa* (koa), *Euphorbia* spp., *Leptecophylla tameiameiae* (pūkiawe), *Melicope hawaiensis* (ʻalani), *Metrosideros polymorpha* (ʻōhiʻa), naio, *Myrsine lanaiensis* (kōlea), *Nestegis sandwicensis* (olopua), *Nothocestrum breviflorum* (ʻaiea), and *Sophora chrysophylla*, some of which are known to be used by anthracinan yellow-faced bees. Currently, these forests are largely comprised of a mix of native/nonnative vegetation.

Diet

With the exception of nonnative tree heliotrope, Hawaiian yellow-faced bee species, including the anthracinan yellow-faced bee, almost exclusively visit native plants (Daly and Magnacca 2003, p. 11) to collect nectar and pollen, pollinating those plants in the process (Cox and Elmqvist 2000, p. 1238; Sahli et al. 2008, p. 1; Sakai et al. 1995, pp. 2524–2528; Shay 2014, entire). Consequently, the bees are almost completely absent from habitats dominated by exotic plant species (Daly and Magnacca 2003, p. 11; Magnacca 2007, pp. 186, 188). Also, Hawaiian *Hylaeus* spp. are dependent on relatively few species of native Hawaiian plants for their nutritional needs (Daly and Magnacca 2003; Magnacca 2007, p. 185). Plants visited by adult anthracinan yellow-faced bees include the natives naupaka kahakai., ʻilima, *Euphorbia* spp., *Argemone glauca* (pua kala), *Heliotropium anomalum* (hinahina), naio, ʻohai, and the nonnative *Heliotropium foetherianum* (tree heliotrope) (Daly and Magnacca 2003 p. 217; Magnacca 2007, p. 181). Nonnative tree heliotrope is naturalized on all of the main islands except Kahoʻolawe (Wagner et al. 1999, p. 398). Several of the coastal *Hylaeus* spp., including the anthracinan yellow-faced bee, have adapted to use, and even favor, the introduced tree heliotrope. This has allowed them to thrive in some places where the native coastal vegetation has been largely lost (Magnacca and King 2013, entire; Magnacca 2020 in litt., entire).

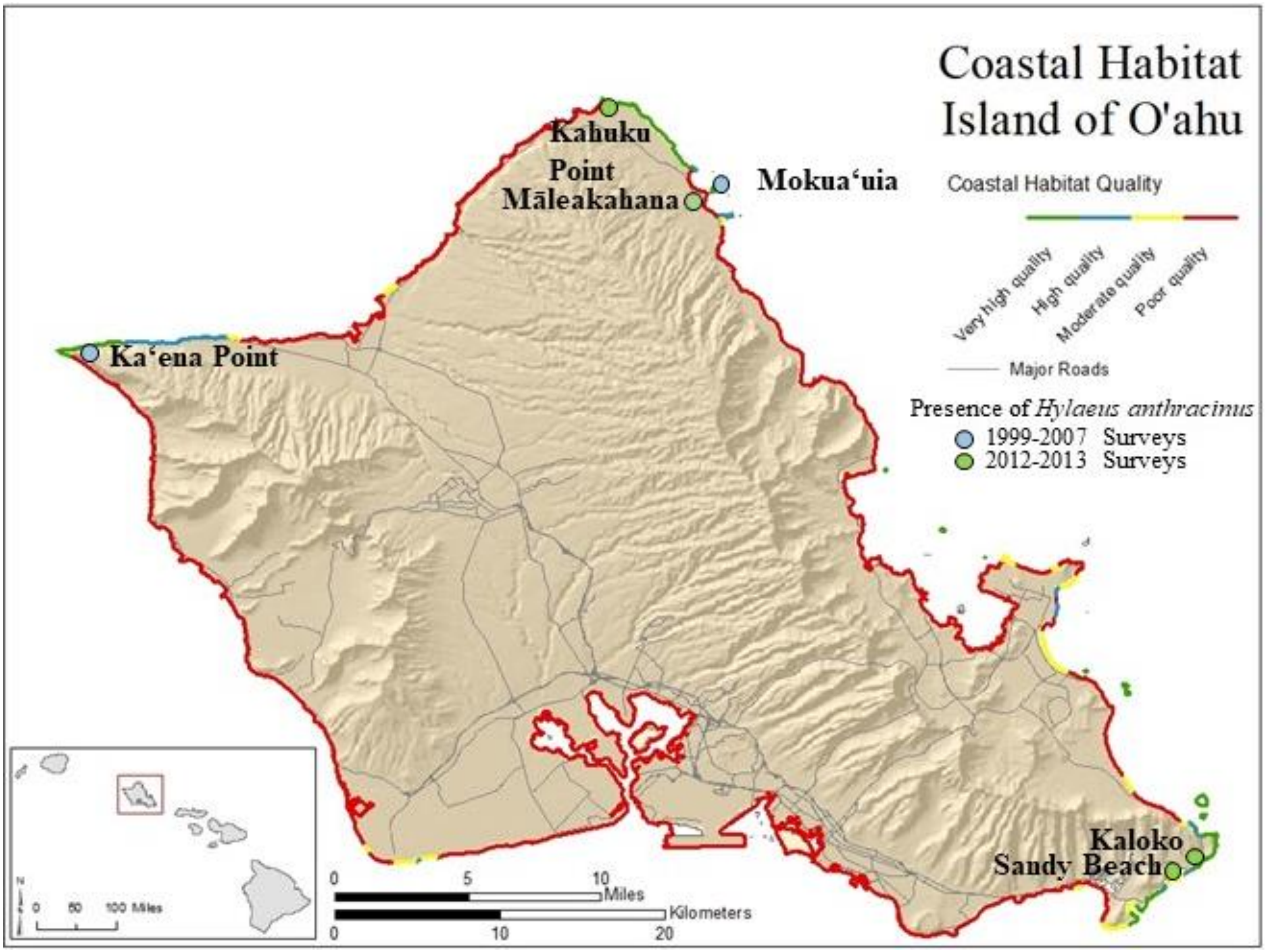

Figure 3. Coastal habitat quality and distribution of anthracinan yellow-faced bee populations on Oʻahu. Map modified from Kim et al. 2020, p. 8.

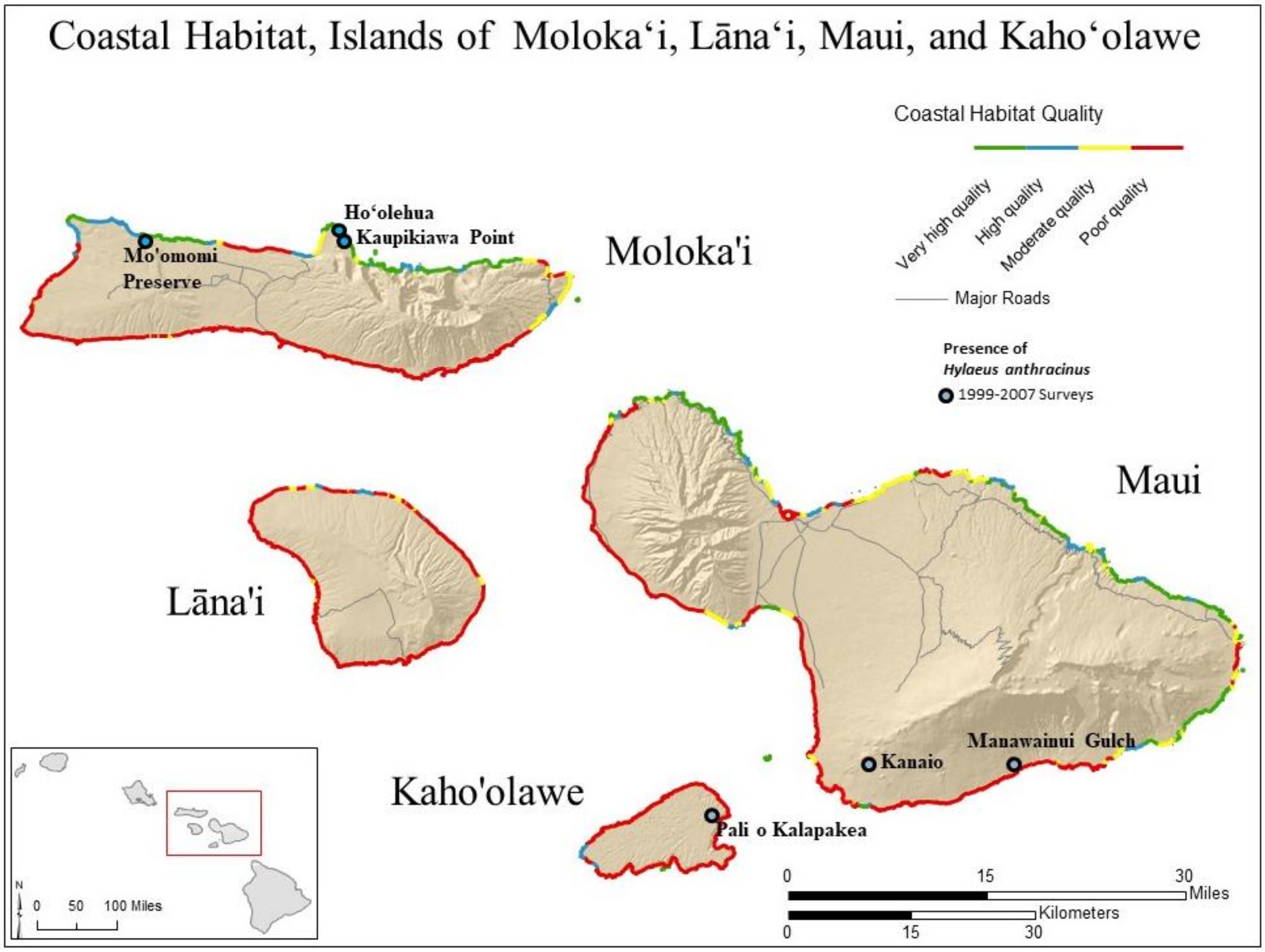

Figure 4. Coastal habitat quality and distribution of anthracinan yellow-faced bee populations in Maui Nui. Map modified from Kim et al. 2020, p. 9.

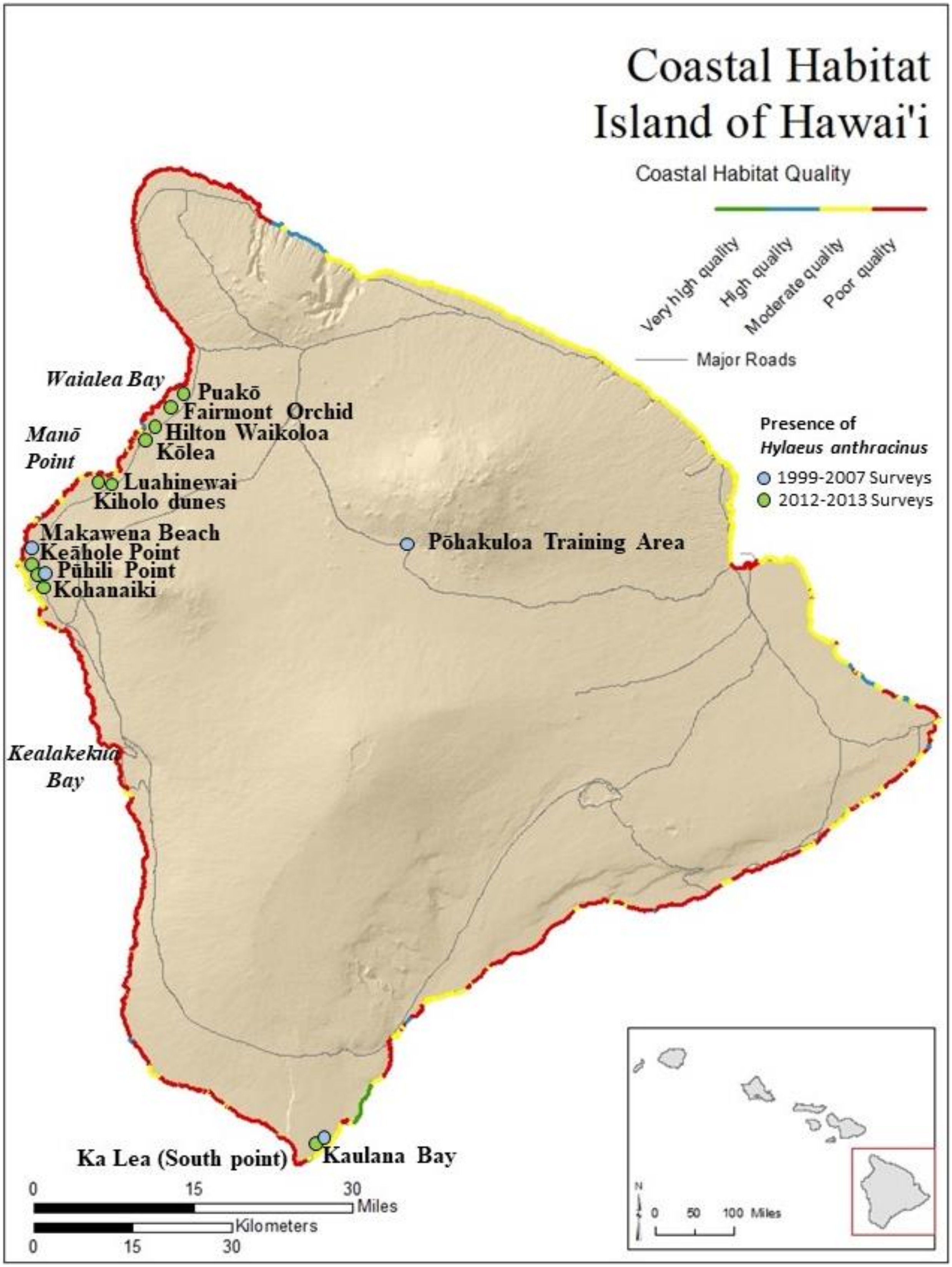

Figure 5. Coastal habitat quality and distribution of anthracinan yellow-faced bee populations on the island of Hawai‘i. Map modified from Kim et al. 2020, p. 11.

Adult yellow-faced bees consume pollen and nectar, but their exact nutritional needs are unknown. According to Magnacca (2007, entire), coastal nesting bees are almost exclusively found in areas dominated by a variety of native shrub and herb species rather than a single species. Naupaka kahakai, for example, is common and widespread in the coastal strand habitat, yet *Hylaeus* are apparently not capable of surviving solely on this plant species (Magnacca 2007 p. 187). Analyses of pollen loads show that coastal *Hylaeus* spp. in particular, use many different plants as food sources, not only seasonally but also at any given time (Magnacca 2007, entire). The presence of diverse, simultaneously available native pollen sources that support the adults and are used for provisioning the nest are a necessary part of suitable habitat for anthracinan yellow-faced bees survival and reproduction.

Life cycle and demographics

For the ground-nesting species like the anthracinan yellow-faced bee, nesting substrate is a strong constraint on habitat suitability (Daly and Magnacca 2003, p. 106; Magnacca 2007, p. 187; Magnacca and King 2013, entire). Ground-nesting species need relatively dry conditions for nesting (Daly and Magnacca 2003, p. 11). Yellow-faced bee species lack the physical characteristics necessary for digging a nest, such as strong mandibles and terminal abdominal plate (pygidial plate) that would allow them to excavate hard-packed soil (Daly and Magnacca 2003, entire; Magnacca 2007 p. 187). As a result, ground nesting *Hylaeus* spp. do not usually initiate their own nest holes; rather they opportunistically utilize vacant burrows made by other insects such as beetles or wasps or natural crevices (Magnacca 2007, p. 188). The anthracinan yellow-faced bee has also been observed nesting in coral rubble on the shoreline (Figure 6. Left), rock walls, and stems of coastal shrubs (Magnacca 2005, entire; Magnacca and King 2013, entire).

Bees in the family Colletidae are also referred to as plasterer bees because they line their nests with a cellophane-like membrane secreted from their salivary and Dufour’s gland (Espelie et al. 1992, entire; Day and Magnacca 2003, p. 9). The female *Hylaeus* spp. lines and provisions her own nest, even if nesting in aggregations, hence the name solitary bees (Daly and Magnacca 2003, entire). After lining the nest, the female lays her eggs and provides her brood (young) with a mass of semiliquid nectar and pollen left alongside her eggs (Day and Magnacca 2003, p. 9). Once provisioned, the nest is sealed with the secreted membrane (Figure 6. Right).

Within the nest, the general life cycle for *Hylaeus* spp. is as follows. The eggs hatch and develop into grub-like larvae (immature stage). As larvae grow, they molt through three successive stages (instars). During this time, the larvae consume the nectar and pollen provisions left for them by their mother (Daly and Magnacca 2003, p. 9; Michener 2000, p. 24). After the third instar, the larvae change into pupae (a resting form). It is in this stage that they metamorphose (i.e., undergo change) and emerge as adults. The brood cycle from egg to adult takes about 30 to 60 days (Graham 2015 in litt., entire), during which time, the solitary females do not provide parental care or defend their brood.

Our knowledge of breeding and longevity behaviors of anthracinan yellow-faced bee individuals is very limited. *Hylaeus* spp. females mate as young adults and store the sperm for the rest of their lives (Daly and Magnacca 2003). Based on Daly and Magnacca (2003, pp. 7–8). *Hylaeus* spp. females, in general, appear to live longer than males. An adult male of the wood-nesting species the furry yellow-faced bee (*Hylaeus pubescens*) survived 74 days (Daly and Coville 1982, p. 76), but little else is known about average longevity of the coastal and dry forest nesting species.

Figure 6. Left. Female anthracinan yellow-faced bee nesting in a piece of coral ruble on the beach strand. Right. Anthracinan yellow-faced bee nest sealed with a cellophane-like membrane. Photo provided by Dr. Karl Magnacca.

Individual Needs

Historically, anthracinan yellow-faced bee individuals were common and widespread through the dry coastal habitats and dry forest habitats. The species now has limited, patchy distributions throughout the islands (Daly and Magnacca 2003, p. 7; Magnacca 2007, entire; Magnacca and King 2013, p. 12). Habitat loss, ant predation, and competition for food have largely reduced the suitable habitat for this species.

Individuals need relatively dry conditions and existing burrows or useable substrates such as coral or hollow plant stems for nesting, though they may forage in nearby habitats that provide native pollen and nectar (Daly and Magnacca 2003, p. 11). At many sites, the bees are restricted to an extremely narrow corridor, typically 33–65 ft (10–20 m) wide, between landscaped or developed areas and the ocean where the bee feeds on nonnative tree heliotrope and naupaka kahakai (Magnacca and King 2013, p. 12). In general, a *Hylaeus* individual needs nutritional resources from a diverse group of native plant species that are simultaneously available; individuals appear to need nutritional variety to survive (Magnacca 2007, p. 187). Additionally, the bee may be present at any time during the year. Thus, the flower species the bee visits may change with the time of year and flower availability. Throughout the year, the bee needs a constant, supply of suitable pollen and nectar from diverse host plants.

The anthracinan yellow-faced bee possess traits that support short-range dispersal (Daly and Magnacca 2003, pp. 7–8). They are relatively strong flyers and are capable of flight in search of food, mates, and nests. Wind may also assist them. In addition, females that have mated store sperm for life and are capable of producing offspring of both sexes (Daly and Magnacca 2003, p. 8). Being strong fliers, *Hylaeus* spp. have a lower rate of island endemism that many other native insect taxa in Hawaiʻi (Magnacca 2007, pp. 173–174). Based on observed lack of single island endemism, the anthracinan yellow-faced bee may be able to cross the narrow water channels within Maui Nui (Maui Nui is comprised of Molokaʻi, Lānaʻi, Maui, and Kahoʻolawe) (Daly and Magnacca 2003, p. 8). This mobility likely facilitates locating mates, shelter, food, and nest resources, within a reasonable distance.

Population Needs

We define anthracinan yellow-faced bee populations based on the different islands they occupy and their geographical distance from one another within an individual island. Though *Hylaeus* spp. are a solitary bee, females can be found aggregated in nesting areas. This is likely due to the suitability and availability of nesting resources. Nest aggregations may also be related to threat level; higher nest density may occur in an area with no threats and available nesting resources. A nest is not defended and the brood is vulnerable to predation. Population growth requires a series of actions: 1) finding a mate; 2) mated females finding a suitable burrow for their nest; 3) availability of appropriate nectar and pollen resources for nest provisioning and adult survival; and 4) offspring survival. Each of these actions have their own threats that must be avoided in order for population stability and growth to occur.

The *Hylaeus* spp., in general, are relatively mobile for short distances. The current patchy distribution of the anthracinan yellow-faced bee can negatively affect proficiency to find a mate, in spite of the bee's mobility. The capability of a young adult female to store sperm after mating and produce offspring of both sexes provides a source of potential reproduction of the species should males be spatially or temporally unavailable during her later life. These characteristics also allow the female to disperse offspring throughout suitable habitat, provided nesting resources can be located that are free of ants or other threats. These traits would potentially lead to and sustain a new population, in the absence of threats. The ability of a population to expand within an occupied site is constrained by the size of the area, availability of food and nesting resources, and condition of the habitat that surrounds the occupied site. The lack of connectivity between suitable coastal habitats impedes the ability of the anthracinan yellow-faced bee to locate distant resources and colonize new areas.

Resiliency is the capacity of an individual or population to withstand stochastic disturbance events. The survival rate of the anthracinan yellow-faced bee offspring, population demographics, and growth rate needed to sustain a population in the presence of threats are unknown. Thus, we base resiliency of the anthracinan yellow-faced bee on population size (abundance) and habitat quality. For the anthracinan yellow-faced bee to be abundant, it must reproduce. This requires mating at least once and having a stable to positive population growth rate.

A key habitat quality that supports reproduction and population growth of the anthracinan yellow-faced bee is the availability of suitable nesting resources. Essentially, this is an existing burrow in dry habitat that meets brood needs. Anthracinan yellow-faced bees have been observed using holes in coral rubble and rock walls (Figure 6). It will also use manmade burrows (Graham 2015, entire). Another key habitat quality that supports individual and brood survival is the availability of diverse native pollen and nectar sources for adult survival and nest provisioning.

Resiliency also depends on absence of threats. The exact cause of the population reduction of a once abundant bee is unknown. The greatest known threat to this bee is the modification or loss of its dry coastal shrubland and dry forest habitats. This loss can be the physical loss of the nesting and foraging habitat or the modification of the habitat by predators, parasitoids, or competitors for resources, that subsequently renders the site unsuitable. The absence of the anthracinan yellow-faced bee despite the presence of food resource availability may be the result of the lack of nesting resource, presence of ants or nest parasitoids, competition for food resources or a combination of factors. Accordingly, a resilient population of the anthracinan yellow-faced bee has abundant individuals, stable to increasing populations in the wild, and quality habitat without threats.

Species Needs

Redundancy is the ability of the anthracinan yellow-faced bee to withstand catastrophic events and is measured by the number of populations (redundancy/duplication), distribution of the populations across the landscape, and connectivity among populations. In order to achieve redundancy, the distribution of anthracinan yellow-faced bee populations across the geographic range should exceed the area of impact of a catastrophic event that would otherwise overwhelm the resilience of the populations. Essentially, the more populations of the anthracinan yellow-faced bee and the broader the distribution of those populations, the more redundancy the species will exhibit thereby increasing its ability to survive a catastrophic event. Captive populations of a species would provide an additional source of individuals that could supplement redundancy. For anthracinan yellow-faced bee, redundancy requires the presence of multiple, stable to increasing populations distributed across its coastal and dry forest ranges on Oʻahu, Maui Nui, and the island of Hawaiʻi.

Representation is the ability of the anthracinan yellow-faced bee to adapt to changing environmental conditions over time and can be measured by having one or more populations of a species occupying the full range of suitable habitat used by the species. Alternatively, representation can be viewed as maintaining the breadth of genetic diversity, within and among, populations. This allows the species to adapt to changing environmental conditions over time. While there are no historic population estimates, qualitative accounts of the anthracinan yellow-faced bee indicate that they were common and widely distributed in their known historical habitat on Oʻahu, Lānaʻi, Molokaʻi, Maui, and the island of Hawaiʻi. Preliminary genetic diversity studies suggest the anthracinan yellow-faced bee may be a complex of species, though supporting biological evidence has not been established (Magnacca and Brown 2010, entire). There is overlap in genetic similarities between individuals from different islands, though we do not know how much genetic variation has been lost since humans arrived in Hawaiʻi. The mobility of yellow-faced bees provides a means of connecting populations to support some genetic exchange and representation. However, connectivity is determined by the distance that can reasonably be achieved by the bee and is severely hampered by fragmentation of suitable habitats. The existing biogeographical range of the anthracinan yellow-faced bee delimits its genetic diversity. The amount of genetic diversity lost by species extirpation on Lānaʻi is unknown, but the species is extant on the other islands within Maui Nui, which may provide some level of genetic representation of the population that once existed on Lānaʻi. The patchy distribution of the species across the five islands it currently occupies likely impedes the genetic exchange that once existed when the species formed a more contiguous population in the coastal and lowland dry forest habitat. Representation is conferred to this species by having abundant individuals in stable to increasing populations dispersed throughout its full coastal and dry forest ranges on Oʻahu, Lānaʻi, Molokaʻi, Maui, Kahoʻolawe, and the island of Hawaiʻi that embody the existing full genetic diversity.

FACTORS INFLUENCING VIABILITY

Threats

Habitat Loss and Degradation

Habitat loss and degradation have contributed significantly to population declines of the anthracinan yellow-faced bee. Native coastal habitat is one of the rarest habitats on each island (Wagner et al. 1999, pp. 45, 54; Cuddihy and Stone 1990, pp. 94–95; Magnacca 2007, p. 180). The coastal strand, dunes, and adjacent dry lowland habitat ecosystem have been modified, degraded, or lost by land use conversion (e.g., development, agriculture, road building), invasion by nonnative species, fire, and environmental changes (Figures 3, 4, and 5; Cuddihy and Stone 1990, pp. 94–95; Kim et al. 2020, entire; Pʻea et al. 2019, entire; Wagner et al. 1999, entire). Nesting and foraging resources are becoming increasingly rare and fragmented (Magnacca 2005, entire; Cuddihy and Stone 1990, entire; Wagner et al. 1999, entire). The occurrence of several of the remaining anthracinan yellow-faced bee populations fronting or near resorts on Oʻahu and the island of Hawaiʻi indicate the species is capable of living in proximity to development (Magnacca and King 2013, p. 24). But, the restricted distributions, which often end abruptly, despite the presence of identical food resources, underscores the need for nesting resources and absence of other threats such as predation and competition. As a result, the anthracinan yellow-faced bee has disappeared from much of its historical habitat.

The majority of the coastal strand and lowland dry forest habitats once occupied by the anthracinan yellow-faced bee are now dominated by invasive plant species that are replacing native flora (Cuddihy and Stone 1990, pp. 73–74; Kim et al. 2020, entire; Javar-Salas et al. 2019, entire; Mascaro et al. 2008, entire; Peʻa et al., 2019, entire; Wagner et al. 1999, p. 52;). Most of the coastal habitats of the Hawaiian islands lack significant amounts of native foraging plants besides naupaka kahakai, which cannot support *Hylaeus* spp. populations on its own (Magnacca 2007, p. 187). Habitat destruction and modification by nonnative plants, such as *Asystasia gangetica* (Chinese violet), *Atriplex semibaccata* (saltbush), *Cenchrus ciliaris* (buffelgrass), *Chloris barbata* (swollen fingergrass), *Digitaria insularis* (sourgrass), *Leucaena leucocephala* (koa haole), *Melinis minutiflora* (molasses grass), *Pluchea indica* (Indian fleabane), *Pluchea carolinensis* (sourbush), *Prosopis pallida* (kiawe), *Psidium cattleianum* (strawberry guava), *Rubus* spp. (blackberry), *Schinus terebinthifolius* (Brazilian peppertree), *Urochloa mutica* (buffalo grass), and *Verbesina encelioides* (golden crown-beard), negatively affect the habitat of anthracinan yellow-faced bee (Cuddihy and Stone 1990, p. 105). Such nonnative plants adversely affect microhabitat by modifying the availability of light, shifting soil-water regimes, changing nutrient cycling processes, altering fire characteristics of native plant habitat, outcompeting natives, and inhibiting the growth of native plant species (Vitousek 1987, p. 224). Each of these effects can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74). This conversion has negative effects on the host plants that yellow-faced bees feed likely feed upon and use for provisioning their nests. *Hylaeus* spp. are dependent on having a variety of native plants for pollen and nectar. The conversion of native plant communities to nonnative communities can also alter or remove ground, twig, or stem nesting sites. The loss of native plant species from coastal and dry lowland habitats is one of the main causes of decline of *Hylaeus* spp., in general (Sakai et al. 2002, pp. 276, 291).

Nonnative animals such as feral pigs (*Sus scrofa*), goats (*Capra hircus*), horses (*Equus ferus caballus*), mouflon sheep (*Ovis gmelini musimon*), axis deer (*Axis axis*), and cattle (*Bos taurus*) are considered one of the primary factors underlying degradation of native vegetation in Hawaiʻi. These habitat changes remove food sources and nesting sites for the anthracinan yellow-faced bee (Stone 1985, pp. 262–263; Cuddihy and Stone 1990, pp. 60–66, 73). Browsing, grazing, and trampling by these mammals degrade native plant communities and facilitate invasion of exotic plants by spreading seeds and creating disturbed areas where seeds can germinate (Hobdy 1993, entire). Specific threats to the *Hylaeus* spp. bee habitat posed by introduced ungulates are: (1) crushing or trampling of nests; (2) trampling and grazing effects on the plants used for pollen and nectar; (3) ungulate paths leading to mechanical damage of host plant roots and substrate erosion; and (4) creation of open, disturbed areas facilitating weedy plant invasion and the establishment of nonnative plants from dispersed fruits and seeds, which results in the conversion of a native community to one dominated by nonnative vegetation.

Fire is a threat to the anthracinan yellow-faced bee because it destroys the dry habitats on which this species depends and opens habitat for increased invasion by nonnative plants. Human alteration of landscapes and the introduction of nonnative plants, especially grasses, has led to greater frequency, intensity, and duration of fires (Brown and Smith 2000, p. 172). Grass-fueled fire often kills most native trees and shrubs (D'Antonio and Vitousek 1992, pp. 70, 73–74). The narrow dry coastal strand habitat of the anthracinan yellow-faced bee are highly vulnerable to wildfire, which destroys food and damages nesting resources. The number and size of wildfires are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect the remaining habitat of this yellow-faced bee at any time (USFWS 2016a, entire; USFWS 2019b, entire). Fire poses a risk to the species because their habitat is located in or near areas that have burned previously or is in areas considered at risk due to the cumulative and compounding effects of drought and the presence of highly flammable nonnative grasses (USFWS 2016a, entire).

Predation, Competition, and Disease

Several nonnative ant species have a deleterious effect on the native *Hylaeus* spp. (Cole et al. 1992, entire; Daly and Magnacca 2003, p. 10; Gagne 1979, entire; Krushelnycky et al. 2005, entire; Krushelnycky et al. 2017, entire; Perkins 1913, entire; Reimer 1993, entire) leading to yellow-faced bee populations being drastically reduced in ant infested areas (Cole et al. 1992; Medeiros et al. 1986, pp. 45–46; Reimer 1993, p. 17; Stone and Loope 1987). Big-headed ants (*Pheidole megacephala*), yellow crazy ants (*Anoplolepis gracilipes*), Papuan thief ants (*Solenopsis papuana*), and tropical fire ants (*Solenopsis geminata*) are aggressive, generalist predators (preying on a variety of species) that occur in coastal and shrubland habitat. Ground-nesting species, like the anthracinan yellow-faced bee, are particularly vulnerable to predation by nonnative ants (Cole et al. 1992, entire; Medeiros et al. 1986, entire). Ants are primarily a threat to the brood (i.e., egg, larvae, pupal stages) because broods are immobile, nests are easily accessible in or near the ground, and are undefended.

In general, big-headed ants and yellow crazy ants are ubiquitous in the habitat of the anthracinan yellow-faced bee. Both of these ant species are abundant and colonize native and nonnative plant communities (Holway et al. 2002, entire; Reimer 1994, entire). Big-headed ants are primarily restricted to dry lowland habitats below 3,289 ft (1,000 m) and are almost always the dominant ants in its habitat. Yellow crazy ants primarily occur from sea level to 2,625 ft (800 m) but have been found up to 4,000 ft (1,200 m) (Medieros et al. 1986, entire). These two species are the most common invasive ant species in lowland areas and are known to colonize both undisturbed native areas and areas dominated by nonnative vegetation. With few exceptions, native insects have been eliminated in habitats where bigheaded ants are present in high numbers (Perkins 1913, p. xxxix; Gagne 1979, p. 81; Gillespie and Reimer 1993, p. 22). From their frequent co-occurrence, *Hylaeus* spp. can evidently tolerate bigheaded ants in at least moderate abundance, however yellow crazy ants appear to severely reduce or entirely exclude *Hylaeus* spp. where they occur in high numbers (Magnacca and King 2013, entire). Consequently, these species represent a threat to the existing populations of the anthracinan yellow-faced bee in their coastal and dry forest habitats (Reimer 1993, p. 14; Reimer 1994, p. 17; Daly and Magnacca 2003, pp. 9–10).

Tropical fire ants are also considered a significant threat to native invertebrates (Gillespie and Reimer 1993, entire) and occurs on all the main Hawaiian Islands (Reimer et al. 1990, entire). Found in drier areas of the Hawaiian Islands, this species has displaced big-headed ants as the dominant ant species in some localities (Wong and Wong 1988, p. 175). Because of the expanding range of this species and its widespread occurrence in coastal habitats, it is a possible threat to the coastal anthracinan yellow-faced bee population on Molokaʻi (Wong and Wong 1988, p. 175).

Papuan thief ants are the only abundant, aggressive ant species that have also invaded coastal and lowland dry habitats. This thief ant species is found from sea level to over 2,000 ft (610 m) on all of the main Hawaiian Islands, and is still expanding its range (Reimer 1993, p. 14). Because of the expanding range of this species and its widespread occurrence in coastal habitats, it is a threat to the coastal anthracinan yellow-faced bee populations or individuals (Reimer et al. 1990, p. 42; Reimer 1993, p. 14).

The threat of ant predation is intensified by the fact that most ant species have winged reproductive adults and can quickly establish new colonies (Staples and Cowie 2001, p. 55). This attribute allows ants to access and potentially destroy otherwise geographically isolated populations of native arthropods (Nafus 1993, pp. 19, 22–23). With few exceptions, native insects have been eliminated in habitats where bigheaded ants are present (Perkins 1913, p. xxxix; Gagne 1979, p. 81; Gillespie and Reimer 1993, p. 22). Consequently, nonnative ant species represent a significant threat to the remaining anthracinan yellow-faced bee populations (Reimer 1993, pp. 14, 17; Daly and Magnacca 2003, pp. 9–10).

In addition to predation, nonnative ants also compete with yellow-faced bees for nectar resources (Daly and Magnacca 2003, p. 9; Holway et al. 2002, pp. 188, 209; Hopper et al. 1996, p. 9; Howarth 1985, p. 155; Lach 2008, p. 155; Magnacca 2015 in litt., entire). Ants, particularly yellow crazy ants, deprive *Hylaeus* spp. of a food by consuming large quantities of nectar without pollinating the plant (Lach 2005, entire). In addition, native *Hylaeus* spp. are less likely to land on flowers occupied by ants (Krushelnycky et al. 2005, p. 9; Magnacca 2015 in litt., entire).

Predation by nonnative western yellow jacket wasps (*Vespula pensylvanica*) is a threat to the anthracinan yellow-faced bee. This wasp species is an aggressive generalist predator that will opportunistically predate *Hylaeus* spp., although yellow-faced bees are not its primary prey source (Gambino et al. 1987, entire). In temperate climates, the wasp has an annual life cycle; but, in Hawaiʻi, colonies often persist through a second year. This allows them to have larger numbers of individuals per colony (Gambino et al. 1987, entire) and thus, a greater impact on prey populations. Most colonies are found between elevations of 1,969 to 3,445 ft (600 to 1,050 m), but they can occur down to sea level, where the anthracinan yellow-faced bee occur (Gambino et al. 1987, p. 169; Graham 2015 in litt., entire). Although the anthracinan yellow-faced bee is a rare solitary bee, the presence of western yellow jacket wasps colonies near a yellow-faced bee nest may extirpate a local population.

Competition from nonnative bees for food resources is a potential threat to the anthracinan yellow-faced bee (Magnacca 2007, p. 188; Graham 2015 in litt., entire; Magnacca 2015 in litt., entire). Most nonnative bees inhabit areas dominated by invasive vegetation and thus, are not competing with *Hylaeus* spp. (Daly and Magnacca 2003, entire). European honeybee (*Apis mellifera*) is one of the exceptions; this social species is often very abundant in areas with native vegetation and aggressively competes with *Hylaeus* spp. for nectar and pollen (Magnacca 2007, p. 188; Snelling 2003, p. 345). European honeybees often act as nectar robbers, using their long tongues to reach the nectar without pollinating the flower of the native plant.

Other nonnative bee species also use the same native vegetation as the anthracinan yellow-faced bee. These include carpenter bees (*Ceratina* spp.), sweat bee (*Lasioglossum* spp.), and the nonnative *Hylaeus albonitens* and *Hylaeus strenuus* (Magnacca 2007, entire; Magnacca et al. 2011, entire; Magnacca et al. 2013, entire; Snelling 2003, entire). *Hylaeus strenuus* has been found on Oʻahu. This newly arrived nonnative *Hylaeus* was found in company with the anthracinan yellow-faced bee at Mālaekahana, and not far away from the populations at Kaloko and Kaʻena. It is potentially a serious competitor for floral resources, and regularly visits both naupaka kahakai and tree heliotrope, the two main food plants of the anthracinan yellow-faced bee (Magnacca and King 2013, entire). The impact of competition for nectar and pollen from nonnative bee species may have a significant impact on the anthracinan yellow-faced bee through competition for pollen, because they are similar in size and probably visit similar flowers (Magnacca 2007, p. 189; Magnacca et al. 2011, entire).

Disease is suggested as a threat because pathogens carried by nonnative bees, wasps, and ants may be transmitted to the anthracinan yellow-faced bee through shared food sources (Graham 2015 in litt., entire). However, we have no reports of this type of disease transmission at this time.

Biological Limitations

As a result of having isolated, patchy populations and low numbers, the anthracinan yellow-faced bee may experience the following: reduced reproductive vigor due to inbreeding depression; reduced levels of genetic variability leading to diminished capacity to respond and adapt to environmental changes; and increased vulnerability to localized catastrophes such as hurricanes, tsunamis, and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173; Magnacca 2015 in litt., entire). Together these may result in loss of representation within the species.

The persistence of the anthracinan yellow-faced bee is hampered by having limited populations, many of which lack connectivity. This leaves the species vulnerable to extinction from natural and anthropogenic caused factors. The demographic structure needed to support the anthracinan yellow-faced bee is unknown. Though *Hylaeus* spp. females can store sperm for their lifetime, small, isolated populations are particularly vulnerable to reduced mating encounter and decreased reproductive vigor caused by inbreeding depression. They may suffer a loss of genetic variability over time due to random genetic drift, resulting in decreased evolutionary potential, and lessened ability to cope with environmental change (Lande 1988, entire).

Environmental Factors

Stochastic events such as hurricanes, earthquakes, and tsunamis can result in the direct loss of the anthracinan yellow-faced bee individuals and brood, nests, and foraging resources due to wind, rain, flooding, and tidal surge. Many populations on an island are situated along the same coast line, leaving all of them vulnerable to a single catastrophic tsunami or hurricane event. The narrow coastal strand habitat inhabited by the anthracinan yellow-faced bee is extremely vulnerable to storm surge and flooding associated with severe storms. Indirect effects include creating disturbed areas conducive to invasion by nonnative plants, which outcompete the native plants (Harrington et al. 1997, pp. 539–540; Mitchell et al. 2005, p. 4–3). This would further decrease the remaining native plant and tree heliotrope dominated habitat that supports this bee species (Bellingham et al. 2005, p. 681). Stochastic events may also alter microclimatic conditions (e.g., soil erosion, decreasing soil moisture) so that the habitat no longer supports the host plants necessary for nectar and pollen or provides nesting substrates or existing burrows. In addition, stochastic events can exacerbate the impacts of other threats such as habitat destruction and modification by ungulates, erosion, invasion of nonnative predators, and increased competition for foraging resources. Small populations are demographically vulnerable to extinction caused by random fluctuations in population size and sex ratio. Thus, random and stochastic events may extirpate a species from an island (Lande 1988, p. 1455).

Random, naturally occurring events such as drought can modify and destroy habitat of the anthracinan yellow-faced bee (Magnacca 2007, entire). The dry coastal and dry forest habitats already incur cyclical droughts, which in turn, affect vegetation flushes and food availability. The bee may survive in small numbers and increase once conditions improve (Magnacca 2007, p. 181), but increase can be exacerbated by low numbers of individuals. Drought also creates disturbed areas conducive to invasion by nonnative plants and eliminates food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015 in litt., entire). Droughts lead to an increase in the number of forest and wildfires (Giambelluca et al. 1991, p. v), causing a reduction of native plant cover and habitat (D'Antonio and Vitousek 1992, pp. 77–79).

Climate change has the potential to adversely affect the anthracinan yellow-faced bee. The species reproduces in the dry coastal and dry forest habitat. Sea level rise may further reduce the already small amount of remaining coastal strand habitat forcing the species to nest at higher densities and simultaneously, becoming more isolated from other populations. Habitats of this species are likely to be affected by changes in temperature, humidity, precipitation and the frequency and severity of storms. These stressors may change the habitats on the islands occupied by the anthracinan yellow-faced bee and exacerbate the threats (Javar-Salas et al 2019, entire; Kim et al. 2020, entire) making the habitats unsuitable for the anthracinan yellow-faced bee.

Conservation Actions

Kaʻena Point, on the western tip of Oʻahu, is a state Natural Area Reserve. Native vegetation is regenerating and being restored at the reserve.

Kahuku Point or Kalaeokaunaʻoa, an area of undeveloped coastline on the North Shore of Oʻahu, was included in 628 acres (ac) (254 hectares [ha]) that were placed into conservation for perpetuity in October 2015 by the State of Hawaiʻi, City and County of Honolulu, U.S. Army, and The Trust for Public Land. A volunteer-based community stewardship and coastline restoration effort stemming from a partnership between North Shore Community Land Trust, Turtle Bay Resort, Hawai'i Marine Animal Response, and U.S. Fish and Wildlife Pacific Islands Coastal Program are restoring approximately 39 ac (16 ha) of the Kahuku Point coastal dune ecosystem; approximately five acres of this coastal sand dune ecosystem are already restored. Actions include removing invasive plants and marine debris and outplanting of over 14,000 native coastal plants. Yellow-faced bees and native host plants including ʻōhiʻa, *Euphorbia* spp., naupaka kahakai, and others are present at the site.

A population of the anthracinan yellow-faced bee occurs on the northwestern coast of Molokaʻi at Moʻomomi Preserve on lands protected by The Nature Conservancy of Hawaiʻi (Daly and Magnacca 2003, entire; Magnacca 2007, entire). The coastal lands consists of native beach flora bordered by mostly exotic trees. The habitat is protected from development but is susceptible to fire and invasion by nonnative plants and invertebrate species.

Two sites known to be occupied by the anthracinan yellow-faced bee on Molokaʻi are in coastal habitat within the Kalaupapa National Historical Park (KNHP), on the eastern coast of the Kalaupapa peninsula (Magnacca 2007, p. 181). The park is cooperatively managed by the National Park Service and the State of Hawaiʻi. This area is actively managed to restore native habitat and to reduce or eliminate many of the common threats to the native plant communities found there, including feral ungulates and wildfire.

One of two known populations on Maui is located in the Kanaio Natural Area Reserve. The reserve is managed by the State of Hawaiʻi, Department of Land and Natural Resources (DLNR) (2020).

On Kahoʻolawe, overgrazing by introduced cattle and goats and the bombing and target practice conducted by the U.S. military, led to soil erosion and the loss of almost all of the coastal and lowland dry forest habitat on this island (Warren 2004, p. 461). In 1993, Congress ended military use of the island, and the Kahoʻolawe Island Reserve Commission (KIRC) was created to manage land use and restore the islands natural resources. Access to the island is limited and controlled by KIRC. Activities on the island include fishing, habitat restoration, historical preservation, and education. Commercial enterprises are currently prohibited on the island (Warren 2004, p. 1). In February 2020, a wildfire burned approximately 9000 ac (3642 ha), or about a third of the island (Kahoʻolawe Island Reserve Commission 2020, entire).

CURRENT CONDITION

Historic Condition

Pre-human Habitat and Species Distribution

Once joined by land bridges, the islands of Molokaʻi, Lānaʻi, Maui, and Kahoʻolawe are collectively referred to as Maui Nui. Oʻahu and Molokaʻi may also have been joined at one time. But the island of Hawaiʻi was never connected to Maui Nui. As the islands eroded and biota developed, the islands became separated by ocean channels. In general, *Hylaeus* spp. are strong fliers and likely flew under their own power, or assisted by the wind, to neighboring islands. The ability of young adult females to mate and store sperm for the rest of their lives would have supported the establishment of neighbor island populations if the species could get there. Daly and Magnacca (2003, p. 8) noted that one-third (21/61) of the known species of yellow-faced bees in Hawaiʻi are not restricted to one island, suggesting at least some *Hylaeus* spp. could cross narrow barriers such as those between the islands of Maui Nui, or possibly between Molokaʻi and Oʻahu.

For the anthracinan yellow-faced bee to successfully colonize an island, diverse, coastal flora that could provide the pollen and nectar to support a coastal and lowland dry forest inhabiting *Hylaeus* spp. would be needed. The plant community would provide sufficient food resources, both temporally and spatially, to support nest provisioning and adult survival. The coastal habitat that ground, crevice and coral nesting *Hylaeus* spp. need would have encircled each island, interrupted only by natural cliffs and streams. The coastal nesting yellow-faced bees known today lack the physical characteristics that would allow them to dig their own nest. Thus, they would have been limited to natural crevices or perhaps, utilized nests made by other native species. Yellow-faced bees would have been abundant throughout the Hawaiian archipelago in the absence of habitat loss from anthropomorphic activities and introduced predators. Competition for pollen and nectar would have been very limited.

Historic trends

In the early 1900's, yellow-faced bee species were ubiquitous throughout the islands (Perkins 1912, p. 688). Historic records for Hawaiian *Hylaeus* spp. are based largely on collections made by Perkins between 1892 and 1906 in collections at the Bernice Pauahi Bishop Museum, British Museum of Natural History, and Oxford University Museum of Natural History (Daly and Magnacca 2003, p. 55; Magnacca 2007, p. 183). Perkins collected on all of the higher islands (Kauaʻi, Oʻahu, Molokaʻi, Maui, Lānaʻi, and the island of Hawaiʻi), with the exception of Kahoʻolawe and Niʻihau (Liebherr and Polhemus 1997, entire).

Perkins' collection records indicate the anthracinan yellow-faced bee was once widespread and abundant in the coastal and dry forest habitat. He also noted that this species was especially abundant in coastal and lowland habitats on Molokaʻi, Maui, and Lānaʻi. On the island of Hawaiʻi, the species was collected from Kealakekua Bay and Kona. On Oʻahu, he collected this species in Honolulu, Waialua, Waiʻanae, in the Waiʻanae Mountains, in Waikiki, at unspecified coastal sites, and one higher elevation site labeled "mts." On Molokaʻi, Perkins collected the anthracinan yellow-faced bee at "lower slopes, mtns" and "plains" (Perkins 1899, entire; Daly and Magnacca 2003, p. 55). On Lānaʻi he collected the anthracinan yellow-faced bee at Mānele. On Maui, he collected specimens at the Wailuku sand hills (Waiehu dunes), with additional specimens labeled "Maui" and "Maui coast" and "Kaulawai." The species probably occurred throughout much of the leeward and lowland areas on Maui Nui and Oʻahu, since their host plants, ʻilima, *Euphorbia* spp, naupaka kahakai, and pāʻū o Hiʻiaka, extended throughout this range, provided suitable nesting resources were available (Liebherr and Polhemus 1997, entire; Magnacca 2007, entire).

Between 1997 and 2008, surveys for Hawaiian *Hylaeus* spp. were conducted at 43 sites throughout the Hawaiian Islands that were either historical collecting localities for the anthracinan yellow-faced bee or potentially suitable habitat for this species. The species was observed at 13 of the 43 survey sites, but it had disappeared from 9 historically occupied sites (Daly and Magnacca 2003, p. 217; Magnacca 2007, entire). Several of the historical collection sites, such as Honolulu and Waikiki on Oʻahu and Kealakekua Bay on the island of Hawaiʻi, no longer have *Hylaeus* spp. habitat, which has been replaced by urban development or is dominated by nonnative vegetation that does not support the anthracinan yellow-faced bee (Liebherr and Polhemus 1997, pp. 346-347; Daly and Magnacca 2003, p. 55; Magnacca 2007, pp. 186–188). The species is believed to be extirpated from Lānaʻi (Daly and Magnacca 2003, p. 55; Magnacca 2007, pp. 177, 182; USFWS 2016a, entire). Additionally, during these surveys the anthracinan yellow-faced bee was absent from 17 other (non-historical) population sites with potentially suitable habitat on Oʻahu, Maui Nui, and the island of Hawaiʻi, though other *Hylaeus* spp. were collected (Daly and Magnacca 2003, entire; Magnacca 2007, p. 182).

Current Condition

The anthracinan yellow-faced bee is most recently known to occur from 14 coastal habitat sites and one lowland dry forest site (Figures 3, 4, and 5**)** as follows: five locations on the island of Hawaiʻi; one location on Kahoʻolawe; two locations on Maui; three locations on Molokaʻi; and four sites on Oʻahu (Daly and Magnacca 2003, pp. 55, 217; Magnacca 2005, entire; Magnacca 2007, entire; Magnacca and King 2013, pp. 13–14). In addition, a single individual was collected in 2004 in montane dry forest on the island of Hawaiʻi; however, the presence of additional individuals has not been confirmed at this Pōhakuloa Training Site (Figure 5; Magnacca and King 2013, entire). The species is believed to be extirpated from Lānaʻi. A more detailed description of the species distribution follows.

Oʻahu

The anthracinan yellow-faced bee was historically known from seven sites on the island of Oʻahu, although two of the coastal sites were not conclusively identified by Perkins and the exact locations cannot not be determined (Perkins 1899, p. 100). This species appears to have declined precipitously since the Perkins collecting period on Oʻahu (1892–1906). Between 1997 and 2008, the anthracinan yellow-faced bee was not found during surveys of five of its historical Perkins-era collection sites. Several of these sites no longer provide suitable habitat for *Hylaeus* spp. because native vegetation has been removed during urbanization, or the sites are dominated by invasive, nonnative vegetation. These sites include Honolulu, Waikiki, the Honolulu mountains, Waialua, and the Waiʻanae coast (Liebherr and Polhemus 1997, pp. 345–347; Daly and Magnacca 2003, p. 55). Between 1999 and 2002, coastal habitat at Makapuʻu and Kalaeloa (Barbers Point) were surveyed, but no *Hylaeus* spp. were found (Daly and Magnacca 2003, entire). The coastal habitat at both sites of known historical occurrence, is degraded and dominated by nonnative vegetation. The anthracinan yellow-faced bee was found on Mokuʻauia islet prior to 2004 (Plentovich 2010, entire). Most recently the species is known from only four sites on Oʻahu (Kaʻena Point Natural Area Reserve, Mālaekahana, Kahuku Point, and the Ka Iwi shoreline) (Figure 3).

Kaʻena Point Natural Area Reserve

Between 1998 and 2008, the anthracinan yellow-faced bee was collected at Kaʻena Point, which is located on the northwest-most point of Oʻahu (Figure 3; Daly and Magnacca 2003, p. 55; Sahli 2008, entire). Females and males of the species were observed on ʻilima and naio (Magnacca 2007, p. 181). Surveys in 2012 failed to relocate the anthracinan yellow-faced bee at the Kaʻena Point population site where it had previously been observed as recently as 2010 (Magnacca and King 2013, pp. 13–14). Most recently, the anthracinan yellow-faced bee and its sympatric species, the Hawaiian yellow-faced bee, have again, both been observed at Kaʻena Point suggesting the species may be resurging at this location (Magnacca 2020 in litt., entire).

Mokuʻauia (Goat Island)

Mokuʻauia is an offshore islet in Lāʻie Bay on the northeast coast of Oʻahu, that encompasses 13 ac (5.3 ha) and reaches a maximum elevation of 15 ft (4.5 m). The entire islet is a State Seabird Sanctuary managed by the State of Hawaiʻi DLNR, Division of Forestry and Wildlife and was designated as critical habitat for the endangered ʻōhai in 2003 (USFWS 2003, entire). This is a native plant commonly used by many *Hylaeus* spp., including the anthracinan yellow-faced bee (Daly and Magnacca 2003, p. 233). From the lack of records, it appears Perkins and other early naturalists did not search Mokuʻauia or other offshore islets for yellow-faced bees. The anthracinan yellow-faced bee was found on Mokuʻauia prior to 2004 (Plentovich 2010, entire), but the bee no longer occurs on the islet. Yellow crazy ants invaded the islet in 2006 and are likely responsible for the bee's elimination (Plentovich 2011, entire; Plentovich 2020 pers. comm., entire) at Mokuʻauia.

Mālaekahana

A small, low-density anthracinan yellow-faced bee population occurs within a small strand of native coastal habitat at Mālaekahana, on the shore directly opposite of Mokuʻauia Islet (Figure 3; Magnacca and King 2013, pp. 13–14). Nonnative *Hylaeus strenuus* was found in company with the anthracinan yellow-faced bee at Mālaekahana (Magnacca and King 2013, pp. 13–14). *Hylaeus strenuus* is potentially a serious competitor for floral resources, and regularly visits both naupaka kahakai and nonnative tree heliotrope, the two main food plants of the anthracinan yellow-faced bee (Magnacca and King 2013, pp. 13–14).

Sandy Beach and Kaloko

The Ka Iwi Scenic Shoreline is located on the southeastern end of Oʻahu and encompasses Sandy Beach and Kaloko (Figure 3). In 2012, two high-density, but small anthracinan yellow-faced bee populations were found at Sandy Beach and Kaloko, approximately 0.75 miles (mi) (1.2 kilometers [km]) apart (Magnacca and King 2013, pp. 13–14). Both sites contain very small patches of relatively intact coastal habitat and associated native coastal plants. At the Sandy

Beach site, the anthracinan yellow-faced bee appears to be nesting in a rock wall, while at the Kaloko site the species was observed nesting in coral rubble located on the shoreline (Figure 6). The species was observed in relatively high numbers at this site (Magnacca and King 2013, pp. 13–14).

Kahuku Point

A low-density anthracinan yellow-faced bee population was discovered on the northernmost tip of Oʻahu, at Kahuku Point in 2012 (Figure 3). The population occurs in scattered patches of native coastal habitat along the coast, extending about 0.6 mi (1 km) eastward from the Turtle Bay Resort golf course (Magnacca and King 2013, p. 14).

Molokaʻi

Perkins collected the anthracinan yellow-faced bee at two unknown sites identified as "lower slopes, mtns," and "plains" (Daly and Magnacca 2003, p. 55). Five sites with potentially suitable habitat were surveyed between 1999 and 2005. The species was not observed in the coastal habitat of Kuololimu near Kaupikiawa Point, nor the sand dune habitat near the Kaluakoʻi resort on the west coast of Molokaʻi (Daly and Magnacca 2003, pp. 217–229; Magnacca 2007, entire). The anthracinan yellow-faced bee was present at three sites: Hoʻolehua Beach and Kaupikiawa Point, both located on the Kalaupapa peninsula, and Moʻomomi Preserve (Magnacca 2007, entire).

Moʻomomi Preserve

Between 1999 and 2001, the anthracinan yellow-faced bee and the rare coastal species, Hawaiian yellow-faced bee, were both collected from naupaka kahakai within an area of native vegetation in Moʻomomi preserve coastal dune habitat (Figure 4; Magnacca 2007, pp. 181, 217). Moʻomomi preserve, located on the northwest coast of Molokaʻi, contains intact coastal dunes dominated by native vegetation, as well as dune and inland areas dominated by nonnative vegetation. The preserve is owned and managed by The Nature Conservancy.

Hoʻolehua Beach and Kaupikiawa Point

In 2005, the anthracinan yellow-faced bee was collected at a coastal site above Hoʻolehua Beach near the tip of the Kalaupapa peninsula, and at Kaupikiawa Point, just to the east (Figure 4; Magnacca 2007, p. 181). Both sites are located within KNHP. The areas on the east side of the Kalaupapa peninsula are largely rocky and devoid of vegetation, but contain scattered patches of native coastal vegetation (Magnacca 2007, p. 181).

Lānaʻi

The anthracinan yellow-faced bee has not been documented on Lānaʻi for over 100 years and is likely extirpated. Nor was the species observed at any of the recently surveyed sites, including Mānele Bay, where it was collected by Perkins in 1899 or Mānele Road. In 1999, the anthracinan yellow-faced bee was also absent from surveys at Shipwreck Beach, and in two lowland dry forest sites near Polihua Road at an elevation of 1,400 ft (427 m) and 1,000 ft (300 m), though another rare coastal species, the Hawaiian yellow-faced bee, often found with the anthracinan yellow-faced bee, was present (Daly and Magnacca 2003, pp. 135, 217, 224; Magnacca 2007, p. 182). Other upland areas surveyed included an area along the Munro Trail and Kaiholena ridge where four *Hylaeus* spp. were found, but the anthracinan yellow-faced bee was absent, the Kahue unit of the Kanepuʻu Preserve, and Garden of the Gods (Daly and Magnacca 2003, pp. 217–229). Despite thorough surveys, the anthracinan yellow-faced bee has not been documented since Perkins in 1899 and is considered extirpated from Lānaʻi (USFWS 2016a, entire).

Maui

Perkins (1899, p. 100), originally described the anthracinan yellow-faced bee as abundant within coastal and lowland habitat on the island of Maui where it was collected from four sites. Several of Perkins collection records lack adequate descriptions of the sites for relocation. The species is currently known from two locations in coastal and lowland dry habitats on Maui.

Wailuku sand hills

One of Perkins primary collection sites for coastal bees on Maui was the Wailuku sandhills, which once supported a diverse bee fauna. Formerly a large expanse of coastal dune habitat, the Wailuku sand hills remain as small remnant dunes and only one, at Waiehu, contains intact native vegetation potentially suitable for *Hylaeus* species. This remnant coastal sand dune covers less than 2.5 ac (1 ha) and is on State lands. The anthracinan yellow-faced bee was not observed during the 1999 and 2001 surveys in this location, though the rare Hawaiian yellow-faced bee was present, which is sympatric with the anthracinan yellow-faced bee (Daly and Magnacca 2003, p. 217). The rest of the dunes have been destroyed by development or are overgrown with the nonnative plant kiawe (Magnacca 2007, p. 182).

Kanaio Natural Area Reserve

The anthracinan yellow-faced bee was collected in 1999 in remnant native lowland dry forest in the Kanaio Natural Area Reserve on the southern slopes of Haleakalā at 2,000 ft (600 m) in elevation (Figure 4; Daly and Magnacca 2003, p. 217). A single male of the species was collected from pua kala. The reserve is a State-protected area of approximately 876 ac (355 ha) and contains patches of lowland dry forest and shrub lands.

Manawainui Gulch (west)

In 1999, The anthracinan yellow-faced bee was collected at Manawainui Gulch, at a site on the southern coast, east of Kahikinui, on east Maui (Figure 4). Six males and one female of the species were collected from ʻilima in this coastal habitat. The land is owned by Department of Hawaiian Homelands (Daly and Magnacca 2003, p. 217).

Kahoʻolawe

Previously unknown on Kahoʻolawe, a population of anthracinan yellow-faced bee was discovered in 2002 in coastal habitat at Pali o Kalapakea, where four specimens (2 males and 2 females) were collected from *Euphorbia celastroides* (ʻakoko) at an elevation of 1,000 ft (300 m) (Figure 4; Daly and Magnacca 2003, p. 217). This species was absent from potentially suitable habitat located at Kamohio on the southeastern coast of the island where other *Hylaeus* spp. were collected.

The Island of Hawaiʻi

The anthracinan yellow-faced bee was first described by Perkins (1899, p. 100) from specimens collected by F. Smith on the Kona (west) coast at Kealakekua Bay. In the intervening 99 years, the anthracinan yellow-faced bee appears to have declined significantly throughout its historical range on this coastline. Between 1997 and 2008, the area around Kealakekua Bay and Keʻei to the south was surveyed but no *Hylaeus* spp. were found. Most of these areas are now either dominated by nonnative plants, such as koa haole, or lack vegetation entirely (Magnacca 2007, entire; Magnacca and King 2013, entire).

The Kailua-Keauhou area is heavily developed, and from Kailua-Keauhou to South Point is mainly younger lava flows with slightly more rainfall, often with nonnative vegetation. Flows older than 5,000 years, such as those from Waialea Bay, near Puakō, northwards and those along most of the coast between Kailua and Kealakekua, tend to have less nonnative tree heliotrope and naupaka kahakai, with kiawe occurring down to the shore (Magnacca and King 2013, p. 7). Further south, the coast is slightly wetter and fewer host plants occur. *Hylaeus* spp. surveys have been rare in these areas because of limited access points. For a description of areas that were searched and where the anthracinan yellow-faced bee was absent, see Magnacca and King (2013, entire).

Most recent surveys on the island of Hawaiʻi indicate anthracinan yellow-faced bees primarily occur on lava flows where the rock is somewhat weathered and nest substrates are present close to the shore (Magnacca and King 2013, entire). Soil development is minimal at these sites. Nonnative plants (e.g., nonnative tree heliotrope, kiawe, etc.) form a scattered to dense line just above the beach or rocky shoreline (Magnacca and King 2013, entire). This habitat is nearly contiguous from Puakō to Kailua-Kona except where it is interrupted by the 1859 and 1800–1801 lava flows (Magnacca and King 2013, p. 7). Throughout the inhabited areas of the Kona Coast, The anthracinan yellow-faced bee can often be found in extremely high densities, with 20–50 or more bees flying around a single nonnative heliotrope at any given time (Magnacca and King 2013, p. 12). The anthracinan yellow-faced bee is known from five locations in coastal habitat (Puakō, Waikoloa, Kīholo, Keāhole Point to Kōhanaiki, and Kaulana Bay), and one location in dry lowland forest area at the U.S. Army, Pōhakuloa Training Area (PTA) (Figure 5).

Puakō

The anthracinan yellow-faced bee occurs from Puakō Village to the south near Mani Lani Beach at Nanuku inlet (Figure 5). Much of this area fronts the Fairmont Hotel property. The species was visiting nonnative tree heliotrope and naupaka kahakai. Other bee species present included European honeybees and carpenter bees that can compete for food resources.

Waikoloa
The anthracinan yellow-faced bee occurs in a developed area around Waiulua Bay fronting the Hilton Waikoloa and heading south to Kolea Condominiums (Figure 5). The anthracinan yellow-faced bee was observed visiting nonnative tree heliotrope, naupaka kahakai, Indian fleabane , and sourbush. Sweat bees, which can compete with the anthracinan yellow-faced bee for food resources, were also present. The anthracinan yellow-faced bee was not found further south at ʻAnaehoʻomalu.

Kīholo
the anthracinan yellow-faced bee is known from coastal habitat areas between Lauhinewai and Manō Point (Figure 5). The species was collected from nonnative tree heliotrope and *Ipomoea pes-caprae* (beach morning glory).

Makalawena Beach and Kekaha Kai State Park
In 2007, the anthracinan yellow-faced bee was collected from the coastal strand habitat of Makalawena Beach, just north of Keāhole Point. It was also collected in the Mahaiʻula section of Kekaha Kai State Park (USFWS 2016a, entire). The park is managed by the DLNR. The bee was not found in surveys conducted in 2012 to 2013, but the difficult yellow-faced bee (*Hylaeus difficilis*) was observed. The nonnative carpenter bee was also observed at the site. The anthracinan yellow-faced bee was also absent north of this area at Kaʻūpūlehu, Kua Bay, Kukio, and at the Four Seasons Hualalai. The Kaʻūpūlehu area is bare lava, less than 500 years old and devoid of vegetation.

Keāhole Point to Kōhanaiki
The largest population of the anthracinan yellow-faced bee presently known on the island of Hawaiʻi occurs from Keāhole Point to Kōhanaiki, where it co-occurs with the difficult yellow-faced bee (Figure 5). Bee occupancy includes the narrow coastal strand habitat of Oʻoma and Pūhili Point, where it has been observed on *Euphorbia* spp and nonnative tree heliotrope (Magnacca 2007, entire; Magnacca and King 2013, pp. 13–14).

Yellow crazy ant occurs in close proximity to this bee population but was not observed on plants visited by the anthracinan yellow-faced bee in 2012 to 2013 studies (Magnacca and King 2013, entire). Importantly, ants were often extremely abundant in the slightly denser, moister vegetation just inland of the coastal strand, where bees were not found (Magnacca and King 2013, p. 13). The southern end of the anthracinan yellow-faced bee population occurs precisely at the boundary between Kōhanaiki and Kaloko–Honokōhau National Historical Park, at a point where the vegetation becomes denser and yellow crazy ants become evident down to the shoreline, suggesting the ants constrain the distribution of *Hylaeus* spp. (Magnacca and King 2013, pp. 13–14). The difficult yellow-faced bee, but apparently not the anthracinan yellow-faced bee, can be found in the protected Kaloko-Honokōhau National Historic Park (Magnacca 2007, entire). The difference in distribution between the two *Hylaeus* spp. may be related to greater ant tolerance by the difficult yellow-faced bee. Just to the south of the park, a few more sites appear to have suitable habitat for the anthracinan yellow-faced bee, but had only the difficult yellow-faced bee (Magnacca and King 2013, p. 13). Beyond Kailua-Kona, Magnacca and King (2013, p. 13) found no *Hylaeus* spp. and few sites with suitable vegetation for yellow-faced bees.

Kaulana Bay near Ka Lae (South Point)

The area near Ka Lae, at the southernmost tip of the island of Hawaiʻi, is believed to be the best coastal habitat for *Hylaeus* spp. on the island (Figure 5; Magnacca 2007). In 2007, Magnacca described South Point as "the only place where all the coastal species on the island (with the exception of *Hylaeus psammobius*) are found together." The anthracinan yellow-faced bee appears to be restricted to an area of younger (5,000–10,000 year-old) lava flows east of Ka Lae at Kaulana Bay, where it and other *Hylaeus* spp. were collected in 1999, 2002, and 2012 (Day and Magnacca 2003; p. 217; Magnacca 2007, p. 181; Magnacca and King 2013, pp. 13–14). The substrate of these lava flows is distinct from the surrounding areas covered by Pāhala ash (Magnacca 2007, p. 181). At Kaulana Bay, the anthracinan yellow-faced bee is found on the flowers of naupaka kahakai and nonnative tree heliotrope.

The population of the anthracinan yellow-faced bee at Kaulana Bay is somewhat disjunct from populations of other *Hylaeus* spp. at Ka Lae. The bee is not found in adjacent areas on older lava flows that have potentially suitable vegetation or other sites to the east along the coast, including Kalu, Kaʻaluʻalu, and Mahana. These areas have abundant ʻilima and pāʻū o Hiʻiaka that the anthracinan yellow-faced bee is known to visit at other locations; however, the bee has not been observed using these food resources at Ka Lae (Magnacca and King 2013, entire). This suggests the anthracinan yellow-faced bee have more stringent habitat requirements than other species of Hawaiian *Hylaeus* spp. found in these areas (e.g., difficult yellow-faced bee, yellow-foot yellow-faced bee). It may be due to nesting constraints. This anthracinan yellow-faced bee population is distant from other populations that occur on the Kailua-Kona coast. Though there is distance between the populations, the Kaulana Bay population is not genetically distinct from other populations and there is a high level of genetic diversity among the Kaulana Bay individuals (Magnacca and Brown 2010, entire). This suggests the anthracinan yellow-faced bee probably occurred along the entire Kailua-Kona coast earlier in time (Magnacca and King 2013, p. 13).

Pōhakuloa Training Area

In 2004, one male anthracinan yellow-faced bee was collected on the southern slopes of Mauna Kea in montane dry forest habitat in PTA at approximately 5,200–5,400 ft (1,590–1,650 m) in elevation (Figure 5; Magnacca 2007). The specimen was found resting inside the fruit capsule of *Hedyotis coriacea* (kadua). The anthracinan yellow-faced bee has not been observed at PTA since 2004 (Magnacca and King 2013 p. 23). It is unknown if this collection was a single vagrant individual or from an established population at the site (Magnacca and King 2013 p. 23).

Summary

The anthracinan yellow-faced bee occurs in four coastal locations on Oʻahu, one coastal and one dry forest location on Maui, a coastal location on Kahoʻolawe, and five coastal and possibly one montane dry forest population on the island of Hawaiʻi. The species has not been documented on Lānaʻi for over 100 years. In general, the populations are small and patchily dispersed. The species was not observed in many areas that contained suitable pollen and nectar sources, suggesting the availability of nesting substrates and threats, such as ants or competition for resources, constrain the location of the populations.

SPECIES VIABILITY SUMMARY

Resiliency

Resiliency is the capacity of an individual or population to withstand stochastic disturbance events. We define resiliency for the anthracinan yellow-faced bee based on population size (abundance), population growth rate, and habitat quality. Historically, the species was very abundant especially in the coastal and lowland habitats on Molokaʻi, Maui, and Lānaʻi (Perkins 1899, entire). Currently, the bee is considered extirpated from Lānaʻi, though it was found on Kahoʻolawe in 2004. The number of individuals in each population is not known, though populations observed at pollen sources appear at high density. This is a much higher number than even the most abundant of the "common" montane *Hylaeus* spp. (Magnacca and King 2013, entire).

The populations are patchy, likely related to availability of resources, especially nesting substrates such as coral rubble. This may limit the abundance of individuals within a population, though at a high density. The species distribution is largely limited and fragmented by the presence of ants, particularly yellow crazy ants, which tend to be more abundant in areas with denser vegetation and higher moisture. In addition, availability of native species and nonnative tree heliotrope, which the anthracinan yellow-faced bee visits, must coincide with bee presence. Remarkably, the species appears to persist near some resort areas. These sites have several characteristics in common. All are rocky shorelines with naupaka kahakai and nonnative tree heliotrope, with either landscaped vegetation, kiawe, or bare rock inland (Magnacca and King 2013, p. 12). The bees are restricted to an extremely narrow corridor between these and the ocean, typically 30–60 ft (10–20 m) wide, and do not occur on sandy beaches or inland, even on landscaped native plants on hotel grounds (Magnacca and King 2013, entire).

Resiliency also depends on a suitable habitat free from threats. The anthracinan yellow-faced bee populations are mostly located in the narrow coastal strand habitat and this habitat is vulnerable to fire, drought, hurricane, or tsunami. This coastal habitat requires active management to prevent degradation of the habitat by nonnative plants and invertebrates, such as ants. The absence of the anthracinan yellow-faced bee throughout its historical range and in areas that have potentially suitable habitat is taken into account when evaluating resiliency.

There is little information about demographics or rate of mating encounter, other than to confirm the species is genetically diverse, though the small populations are patchy and isolated. To be resilient, the anthracinan yellow-faced bee needs abundant individuals in multiple, stable to increasing populations in the wild and high quality habitat. The extant populations of the anthracinan yellow-faced bee has deficiencies in the basic characteristics of resiliency and is in danger of extirpation.

Resiliency of the anthracinan yellow-faced bee is low to moderate based on: 1) only 15–16 small populations spread across five islands and absence of the species on Lānaʻi where it historically occurred; 2) absence of the populations from sites with potentially suitable habitat; 3) imminent threat of population extirpation by a stochastic event such as drought, fire, or lack of resources to survive and reproduce; and 4) imminent threats from nonnative species, such as ants.

Redundancy
Redundancy is the ability of the anthracinan yellow-faced bee to withstand catastrophic events and is measured by the presence of multiple, stable to increasing populations distributed across its historical (coastal and lowland montane) ranges on O‘ahu, Maui Nui, and the island of Hawai‘i. The species has spatial redundancy on O‘ahu, Moloka‘i, Maui, and the island of Hawai‘i. However, most of the populations on Moloka‘i, the island of Hawai‘i, and Kaho‘olawe are located along the same shoreline, making them vulnerable to a catastrophic event such as tsunami or hurricane that could destroy the population and its resources for nesting and foraging. The species may have some limited temporal redundancy that would be conveyed by its mobility and thus, ability to survive a catastrophic event by sheltering. However, this also requires its plant hosts also survive and nesting resources can be located. Essentially, the anthracinan yellow-faced bee has low to moderate functional redundancy.

Representation
Adequate representation for the anthracinan yellow-faced bee to persist and adapt to changing environmental conditions over time would require having multiple stable to growing population on O‘ahu, Moloka‘i, Maui Nui, and the island of Hawai‘i in suitable coastal and dry lowland forest habitats free of threats. Much of the historical coastal habitat and dry lowland forest has been lost or is highly degraded. Native habitat remaining is fragmented and varies by island. The diversity of habitat and the breadth of genetic diversity is strongly influenced by the current and historic biogeographical range of the anthracinan yellow-faced bee. While there are no historic population estimates and little genetic information, qualitative accounts of anthracinan yellow faced bee indicate that they were widely dispersed and abundant in their habitat. In recent decades, the anthracinan yellow-faced bee have been absent at sites previously occupied. Recent genetic analyses show the population to contain a relatively high level of genetic diversity, though we do not know how much genetic variation has been lost since humans arrived in Hawai‘i. The mobility of anthracinan yellow-faced bees provides a means of short-range connectivity between populations, which in turn, can support genetic exchange and representation. However, genetic exchange is limited by the isolation of the populations and fragmentation of potentially suitable habitat free of threats. Representation of the anthracinan yellow-faced bee is conferred by stable to increasing populations embodying the existing full genetic diversity being dispersed throughout its historical coastal and dry forest ranges. The multiple small extant populations on five islands provides only moderate representation.

Summary
the anthracinan yellow-faced bee is currently known to occur on five islands in the coastal strand and dry lowland forest habitats. Though multiple populations occur on four of the islands, the populations are largely isolated and highly vulnerable to threats from fire, ants, tsunami, and habitat loss. Anthracinan yellow-faced bees have low to moderate resiliency because of small population size and disjunct populations. The species has low to moderate redundancy because the species is extirpated from Lāna‘i and greatly reduced across its historic range on the islands where it is extant. Species representation is moderate because populations are isolated, but genetic diversity is present.

Based on these considerations, the current viability of the anthracinan yellow-faced bee is low to moderate (Table).

Table. Viability summary of the anthracinan yellow-faced bee under current conditions.

Species	**Resiliency**	**Redundancy**	**Representation**	**Viability**
Hylaeus anthracinus	Low to moderate	Low to moderate	Moderate	Low to moderate

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